ROLE OF IMMOBILIZATION OF IRRADIATED RATS IN THE PROTECTIVE EFFECT OF BONE MARROW SHIELDING

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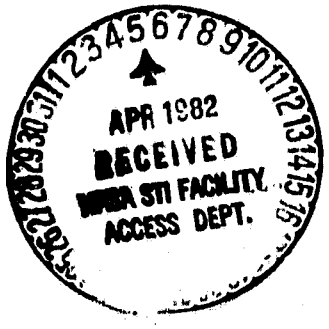
Translation of "O Znachenii Immobilizatsii Krys Pri Obluchenii v Zashchitnom Effekte Ekranirovaniya Chasti Kostnogo Mozga", Radiobiologiya, Vol. 20, No. 2, 1980, pp. 259-262.



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16. Abstract

In experiments on rats exposed to X-radiation, a study was made of the influence on survival of animals of their immobilization and shielding of part of bone marrow during exposure. It is concluded that (1) beneficial effect of the stress factor, created by immobilization of rats during exposure, can aggregate with the effect of bone marrow shielding and, under certain conditions, imitate the latter; (2) the probability of the protective effect of immobilization should be taken into account when assessing the influence of bone marrow shielding.

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IMPORTANCE OF IMMOBILIZATION OF IRRADIATED RATS IN THE PROTECTIVE EFFECT OF BONE MARROW SHIELDING

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Immobilization of animals induces redistribution of cellular elements of the blood and hemopoietic organs, temporary hyperplasia of the myeloid tissue and other processes of an adaptation nature [1]. There are published data regarding a decrease in radiation damage during stress effects [2-4]. The action of adrenaline causes a similar effect. Its administration before irradiation increases the survival rate of the irradiated mice [5,6 and others]. /259** /260

This publication clarifies the degree to which immobilization of rats during irradiation protects them from irradiation death and how the combined effect of two factors is manifest: immobilization of animals by tying to a machine during irradiation, and screening part of the bone marrow, which, as is known, promotes survival of the animals by dispersing the stem cells and repopulating the irradiated aplastic bone marrow [7].

Material and Technique

In the three series that we conducted on mongrel male rats, with irradiation respectively of 700, 820 and 900 R doses, a comparison was made of the dynamics of animal death after total irradiation when they were immobilized by tying to the machine for the time of irradiation, and death of the animals who spent the irradiation time in plexiglass boxes. Other experiments of the same series compared

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the effects of tying the rats with incomplete irradiation. In these experiments, the animals were screened during the irradiation by a lead sleeve (thickness of wall 5 mm) on one limb (shin) or four limbs (two shins and two forearms which corresponds to increasing the shielded volume of bone marrow by roughly 3-fold). Under these conditions, both the immobilization of the animals and the screening of part of the bone marrow could influence the rat survival rate.

In all the experiments, the limbs that were screened during irradiation of the rest of the body were preliminarily (3 h) exposed to local irradiation in a large dose (1500 R). This could promote attenuation of radiation sickness because of reimmigration of the stem cells that initially had immigrated and reproduced in the irradiated bone marrow. For details on the technique see publication [8]. The irradiation conditions were: voltage 180 kW, current strength 15 mA, filters 0.5 mm Cu + 1.0 mm Al, skin-focal distance 60 cm, dosage power 90 R/min. It was shown in a special series of experiments that tying in a position on the back and on the stomach did not affect the irradiation results. After irradiation, the rats were kept under the same conditions.

Results and Discussion

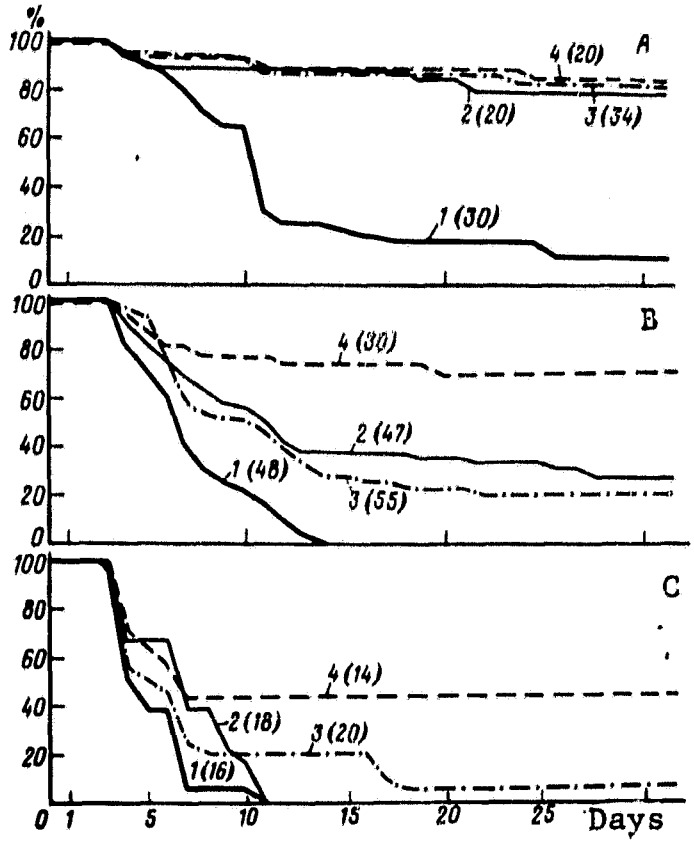
The figure illustrates the results of experiments with survival rate of rats irradiated under different conditions respectively of doses 700, 820 and 900 R. It follows from the cited data that with dose of 700 R (figure, A), in which the total irradiation without tying resulted in the death of ≈ 80% of the animals (curve 1), screening of four limbs (curve 4) and one limb (curve 3) of the tied rats caused the same protective effect as tying without screening (curve 2). This can be explained by the fact that tying alone without screening guaranteed the survival of almost all the experimental animals. With total irradiation in a dose of 820 R (figure, B), all the animals died by the 14th day (curve 1). Screening of the four limbs (curve 4) in this case yielded a greater protective

effect than immobilization of the unscreened animals (curve 2). Screening of one shin of the immobilized rats (curve 3) did not protect them from death to a greater degree than tying to the machine alone.

In the series of experiments with dose of 900 R (figure, C), the death of all the totally irradiated animals occurred already by the 11th day (curve 1). Under these conditions, immobilization without screening did not yield a positive result at all (curve 2) while screening of four limbs (curve 4) in combination with immobilization prevented the death of a considerable number of animals (all the animals survived that did not die from gastrointestinal syndrome). In the experiments with radiation dose of 900 R, screening of one shin (curve 3) had almost no effect on the rat survival rate. Out of 20 animals, only 1 survived to the 30th day after irradiation. The insignificant protective effect of screening one shin in this case agrees with the lack of effectiveness of immobilizing totally irradiated rats, and with the same protective effect of immobilizing and screening one shin when irradiating the animals with a dose of 820 R. /261

Analysis of the dynamics of rat death indicates that with total irradiation, immobilization of the animals for the time of radiation effect in a sublethal dose (700 R) and minimum absolutely lethal dose (820 R) distinctly reduces the death of the animals and is not effective with a dose of 900 R that causes 100% death of rats in 11 days.

Since irradiation of rats with screening of part of the body is usually combined with immobilizing them on machines for the period of irradiation, it was important to clarify whether the protective effect of screening is reduced to the effect of immobilization of animals, and if this is true, then under what conditions, and to what degree.



Dynamics of Death of Rats under Different Conditions of the Effect of X-Rays

Key:

Irradiation in doses:

A. 700 R
B. 820 R
C. 900 R
1. Total irradiation without immobilization
2. Total irradiation with immobilization
3. Irradiation with screening of one limb
4. Irradiation with screening of four limbs

On y-axis: survival rate of animals,%
On x-axis: days after irradiation
In parentheses: number of animals used in experiment.

The findings indicate that screening of a small volume of the bone marrow (one shin) with a sublethal dose and lethal dose close to it has no effect on the survival rate of immobilized rats. The protective effect under these conditions can be entirely explained by immobilization of the animals. With a dose of 820 R, screening

of a greater volume (four limbs) acquires importance since the percentage of surviving rats because of screening doubles. One can /262 acknowledge that weakening of the damage as a result of tying the rats and screening is summed. With an increase in the radiation dose to 900 R at which half of the experimental animals die from gastrointestinal syndrome, immobilization of the animals does not cause a protective effect. At the same time, screening of a fairly large amount of bone marrow (four limbs) guarantees survival of the rats that did not die from intestinal syndrome.

It is obvious that in evaluating the protective effect of screening part of the bone marrow on irradiated rats, one should take into consideration the possibility of weakening the effect of radiation through immobilization.

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